

# **Sensing the World Around You – With Linux and other bits**

Brian DeLacey

BLU @ MIT, 5/20/2015



# Agenda

- 6:30 - 7:15 - Jerry and John, open BLU discussion
- 7:15 - 7:45 - Zigurd Mednieks, "Orders-of-magnitude-advances in Sensing Technology"
- 7:45 - 8:30 - Brian DeLacey, Technical hands on hacking with sensors and TI's new MSP432 on Linux
- 8:30 - 9:00 – Discussion – Arun, Zigurd, Brian, All
  - General Questions
  - Sensing technology and IoT
  - What is the O/S for the Sensing world?
  - Give Away Items thanks to Texas Instruments

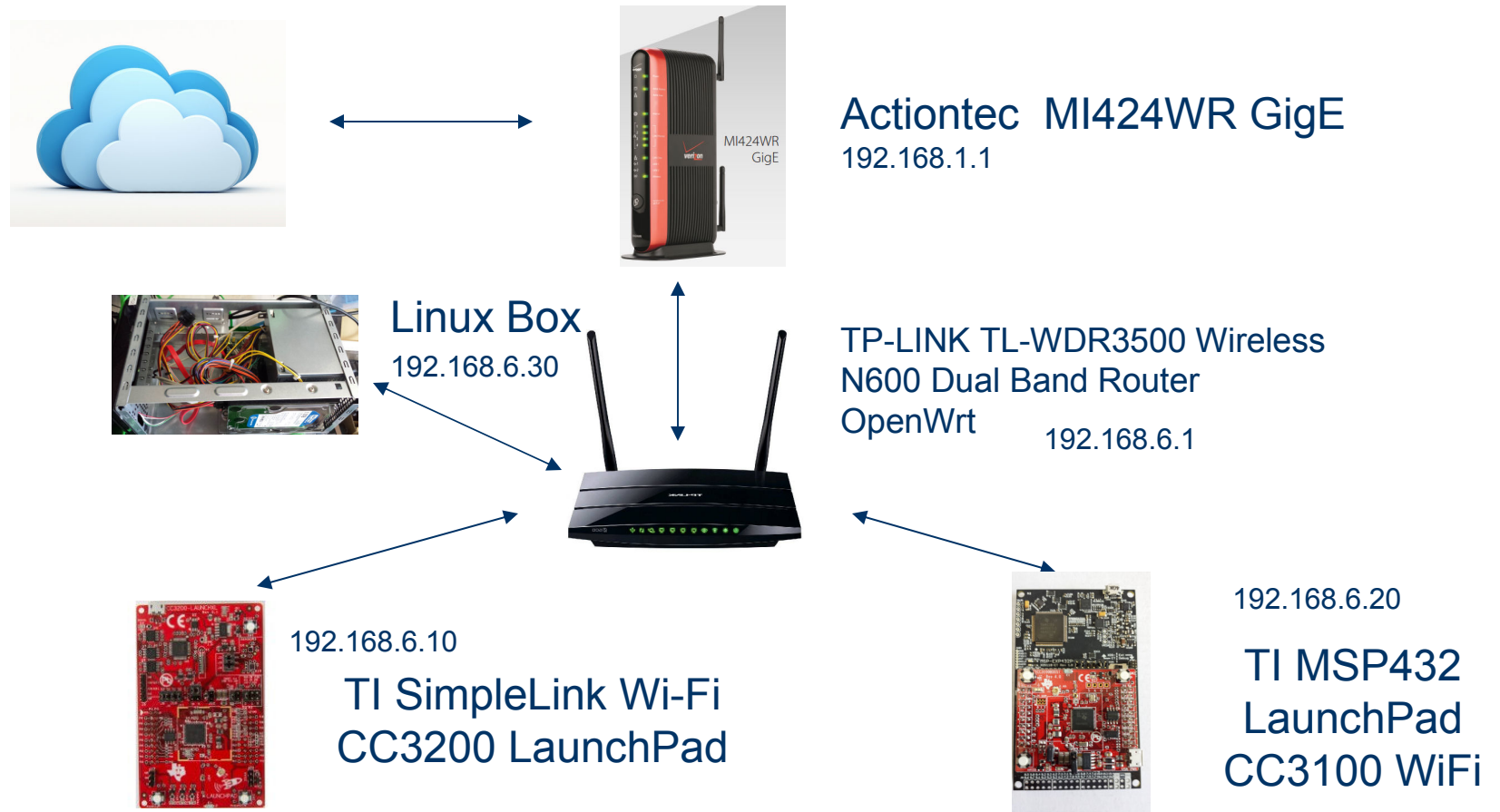
*Details and Recap at <http://blu.org/cgi-bin/calendar/2015-jun>*

# Spoiler Alert: Lessons Learned

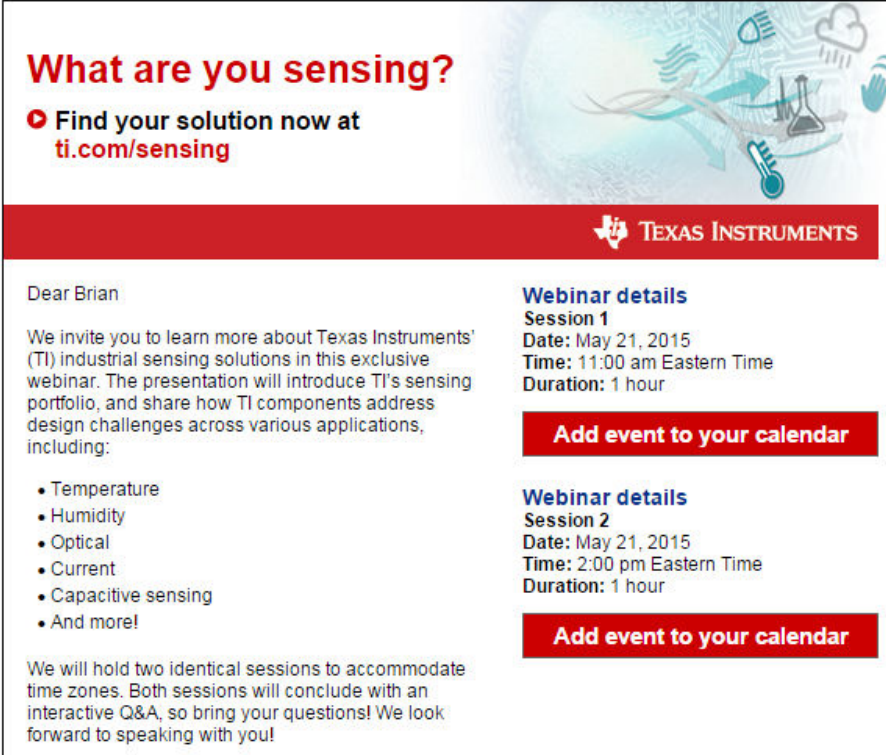
- Familiar and Fun
- Relatively Low Cost
- Vast Introduction to Landscape of
  - Computers / Hardware
  - Electronics
  - Programming / Software
  - Communications / Radios / Wireless
  - Real-world, Sensor-based applications
- Some tricks you'll learn on the fly
  - Flaky cables, shared power rails, beware the motors

*Manage Data Locally While Sharing Globally  
With User-Controlled Programs and Preferences*

# End Result: IoT Network Topology



# What are you sensing?



**What are you sensing?**

Find your solution now at [ti.com/sensing](http://ti.com/sensing)

Dear Brian

We invite you to learn more about Texas Instruments' (TI) industrial sensing solutions in this exclusive webinar. The presentation will introduce TI's sensing portfolio, and share how TI components address design challenges across various applications, including:

- Temperature
- Humidity
- Optical
- Current
- Capacitive sensing
- And more!

We will hold two identical sessions to accommodate time zones. Both sessions will conclude with an interactive Q&A, so bring your questions! We look forward to speaking with you!

**Webinar details**  
**Session 1**  
Date: May 21, 2015  
Time: 11:00 am Eastern Time  
Duration: 1 hour

[Add event to your calendar](#)

**Webinar details**  
**Session 2**  
Date: May 21, 2015  
Time: 2:00 pm Eastern Time  
Duration: 1 hour

[Add event to your calendar](#)

<http://www.ti.com/sensors>

# Texas Instruments - Sensing

**Sensing Innovation**  
Delivering better solutions today and new possibilities for tomorrow

**HDC1000 integrated humidity and temperature sensor**

[Learn more](#)

**What are you sensing?**

Biosensing	Gas	Material composition	Proximity
Chemical	Humidity	Occupancy	Temperature
Current / power	Level	Position / motion	
Flow	Light	Pressure	

# CC2650STK-SimpleLink™ Bluetooth Smart®/Multi-Standard SensorTag

## TI Sensor Tag



- Infrared and Ambient Temperature Sensor
- Ambient Light Sensor
- Humidity Sensor
- Barometric Pressure Sensor
- 9- axis Motion Tracking Device – Accelerometer, Gyroscope and Compass
- Magnet Sensor

	Bluetooth Smart	6LoWPAN	ZigBee
Price	\$29 <a href="#">Buy Now</a>	\$29 <a href="#">Buy Now</a>	\$29 <a href="#">Buy Now</a>
Battery type	Coin cell	Coin cell	Coin cell
Connects to Internet	Smartphone	BeagleBone gateway	BeagleBone gateway
Beacon support	✓		
DevPack support	✓	✓	✓
Mesh network		✓	✓
Range	50m / 150ft	100m / 300ft (extended with mesh network)	100m / 300ft (extended with mesh network)
Max number of devices	8	200	200
Battery lifetime*	1 year (1 second report interval)	1 year (1 second report interval)	1 year (1 second report interval)
User Interface	App	App, Web	App, Web

[http://www.ti.com/ww/en/wireless\\_connectivity/sensortag2015](http://www.ti.com/ww/en/wireless_connectivity/sensortag2015)

# Internet of (some) things



“In 2015, a modern-day gold rush has taken the technology sector by storm.”

“The solution lies not in the internet of *everything*, but rather the internet of *some things*, which may include brand-new investments in new “smart” assets. Or more likely, tapping into existing sensor networks and equipment with embedded intelligence which have been sitting idle.”

<http://techcrunch.com/2015/05/19/the-internet-of-some-things/#.ffl8cn:OFBk>



# Data Mining, in your backyard








1. C4.5
2. k-means
3. Support vector machines
4. Apriori
5. EM
6. PageRank
7. AdaBoost
8. kNN
9. Naive Bayes
10. CART

*A really good overview ...*

<http://rayli.net/blog/data/top-10-data-mining-algorithms-in-plain-english/>

# LaunchPad EcoSystem

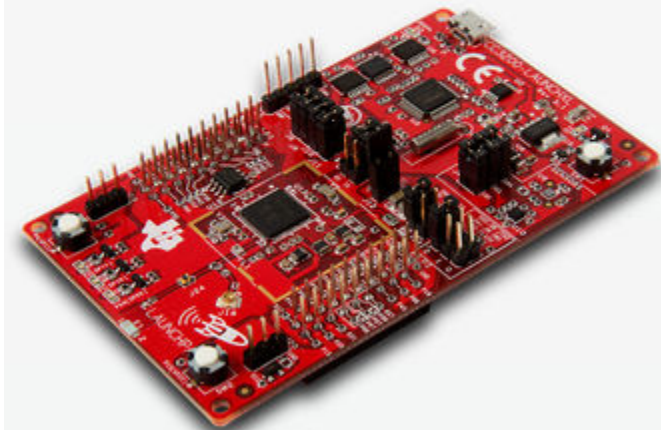
<p>MSP LaunchPads</p> 	<p>C2000 LaunchPads</p> 	<p>Connected LaunchPads</p> 	<p>Hercules LaunchPads</p> 	<p>LaunchPad Brochure</p> 
Ultra-Low Power	Real-Time Control	Get connected	Safety	Brochure
— Starting at				
\$9.99 <a href="#">Buy Now</a>	\$17.00 <a href="#">Buy Now</a>	\$12.99 <a href="#">Buy Now</a>	\$19.99 <a href="#">Buy Now</a>	

<http://www.ti.com/ww/en/launchpad/launchpads.html>

# Let's focus on these two ...

CC3200-LAUNCHXL

\$29.99



MSP-EXP432P401R

\$12.99



<http://www.ti.com/ww/en/launchpad/launchpads-connected-cc3200-launchxl.html#tabs>

<http://www.ti.com/ww/en/launchpad/launchpads-msp430-msp-exp432p401r.html#tabs>

# And programming with Energia...



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## Prototyping Software to Make Things Easy

03/24/2015 – Energia 15 is available!. The release is available for download from [here](#).

Aside from bug fixes this release adds support for the new ARM Cortex M4F based MSP432 LaunchPad. This time it's a bit different though! The framework is powered by TI-RTOS letting you run your Sketches in parallel. Yes, in parallel! How awesome is that?! This release supports MT for the MSP432 LaunchPad with other boards support coming in future releases. Find out more about multitasking @ [Energia MT](#)

### So, what is this all about then?

Energia is an open-source electronics prototyping platform started by Robert Wessels in January of 2012 with the goal to bring the Wiring and Arduino framework to the Texas Instruments MSP430 based LaunchPad. The Energia IDE is cross platform and supported on Mac OS, Windows, and Linux. Energia uses the [mspgcc](#) compiler by Peter Bigot and is based on the [Wiring](#) and [Arduino](#) framework. Energia includes an integrated development environment (IDE) that is based on [Processing](#).

### [Official 430h Energia Forum](#)

[Energia Source Code](#)

[Energia GitHub Wiki](#)

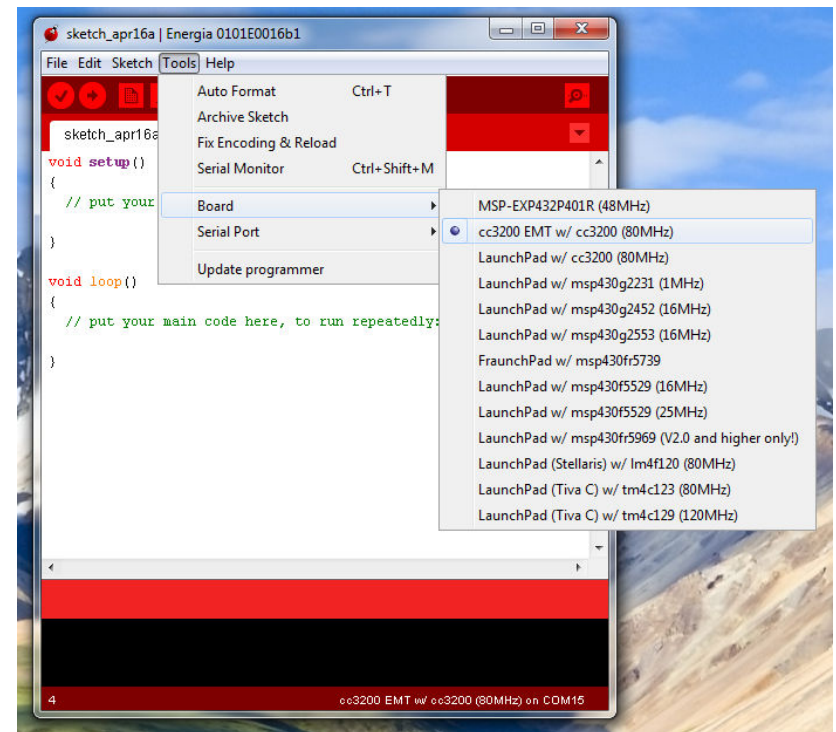
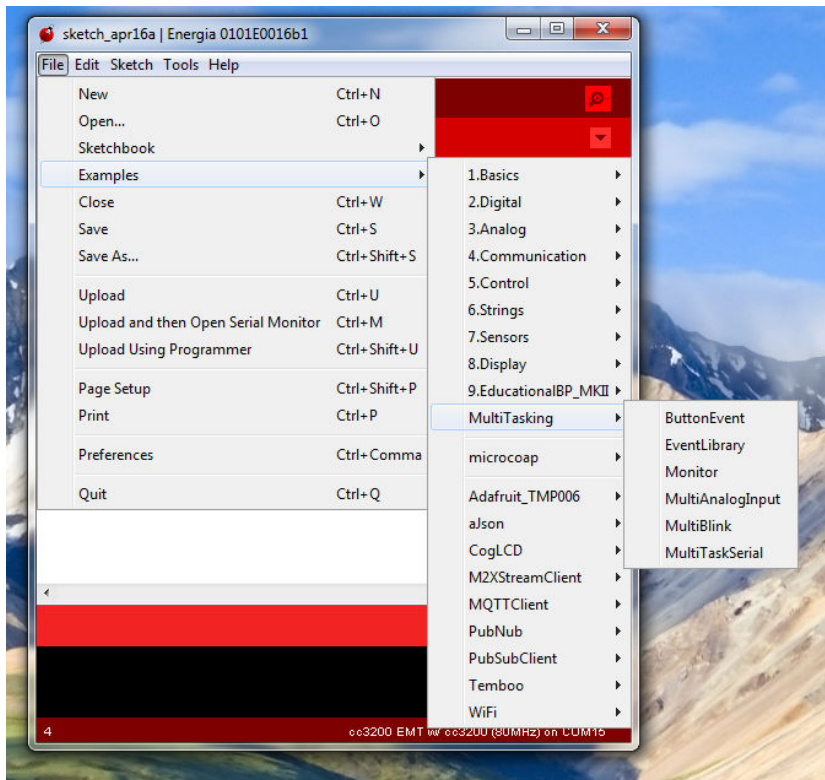
[Energia API References](#)

[Energia Libraries](#)

### **LaunchPad Pin Mapping and Board Setup Instructions:**

- [C2000 F28027 LaunchPad](#)
- [CC3200 WiFi LaunchPad](#)
- [MSP430F5529 LaunchPad](#)
- [MSP430FR5739 Experimenter](#)
- [MSP430FR5969 LaunchPad](#)

# Installing Energia MT for TI-RTOS



# Multi-Tasking Real-Time Operating System with low-cost SOCs

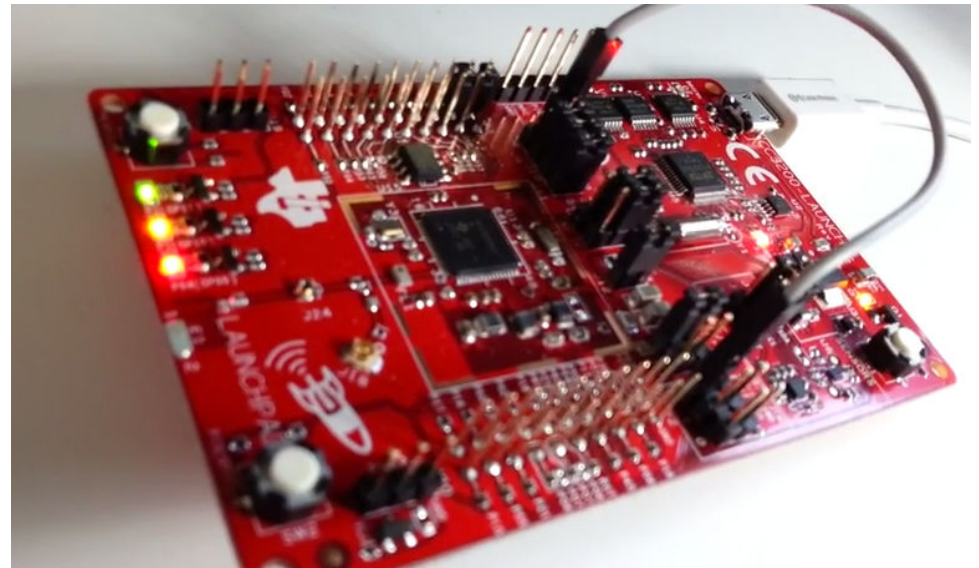


**Energia**

[Home](#) [Download](#) [Guide](#) [Reference](#) [Blog](#) [Store](#) [Getting Help](#) [IRC](#) [Energia Projects](#) [Events](#)

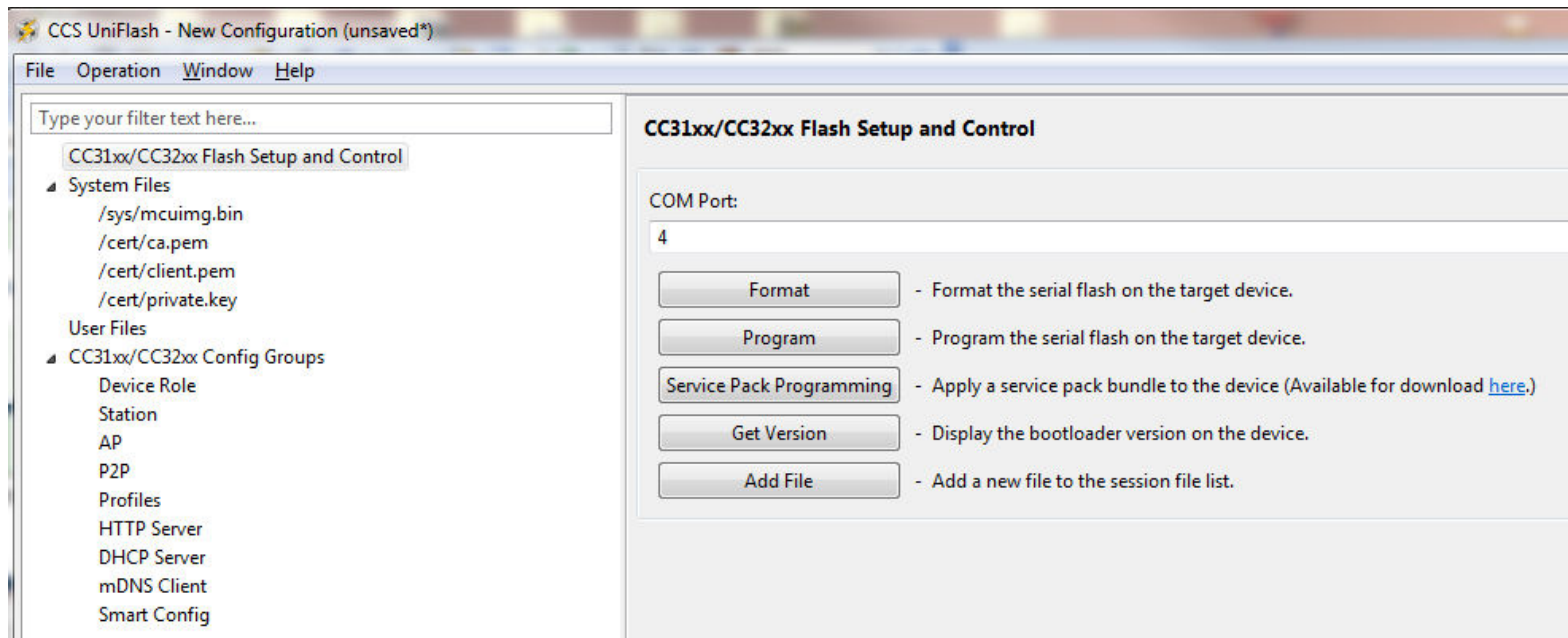
## Multitasking

Multitasking is the ability to run multiple tasks or threads concurrently on a microcontroller. In Energia MT, multitasking is achieved by treating each tab as a separate task and letting [TI-RTOS](#) and Energia take care of the rest. Currently, Multitasking is supported on the MSP432 launchpad.



<http://energia.nu/guide/multitasking/>

# Maybe, Some Configuration



[File, New Configuration]

Then click on "Service Pack Programming"

When you are prompted to restart, just press the RESET button (SW1)

# Pin Mapping – CC3200



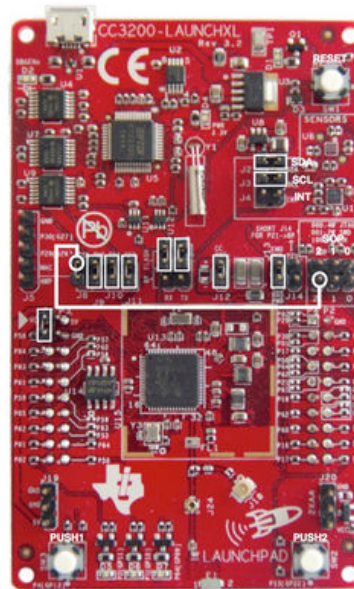
SRAM 256 KB  
Flash 1 MB  
Serial hardware

Analog input < 1.46V

Storage in Flash, execution in SRAM

## LaunchPad with CC3200

Revision 3.2



Hardware
Pin number
Other pin number
IPC
Serial UART
SPI
analogRead()
digitalRead() and digitalWrite()
digitalRead(), digitalWrite() and analogWrite()

			P1	P3		
		+3.3V	1	21	VBUS	
			2	22	GROUND	
RX			3	23		
TX	INT	PUSH1	4	24		TX (2)
			5	25		
			6	26		
SCK			7	27		
			8	28		
TX (1)	SCL	YELLOW_LED	9	29	RED_LED	
RX (1)	SDA	GREEN_LED	10	30		
					GROUND	
					GROUND	
					VBUS	

				P4	P2		
TX (1)	SCL	ANTSEL1		40	20	GROUND	
RX (1)	SDA	ANTSEL2		39	19		
				38	18		CS
				37	17		
				36	16	RESET	
				35	15		MOSI
				34	14		MISO
				33	13	SOP2	
				32	12		RX (2)
				31	11	PUSH2	
						GROUND	
						GROUND	
						+3.3V	

Rei Vilo, 2012-2014  
embeddedcomputing.weebly.com  
version 1.2 2014-09-23

[http://energia.nu/pin-maps/guide\\_cc3200launchpad/](http://energia.nu/pin-maps/guide_cc3200launchpad/)



# Pin Mapping – MSP432



SRAM 64 KB  
Flash 256 KB  
Serial hardware  
ADC 14 bits

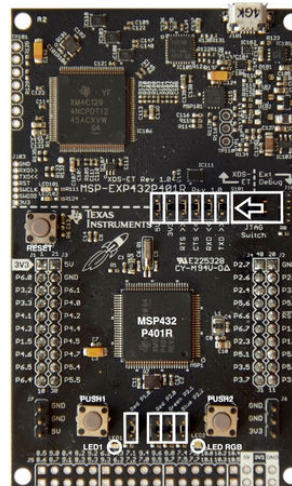


GROUND  
GROUND  
+5V

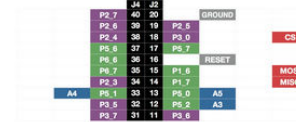
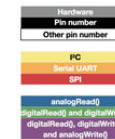


LaunchPad with MSP432

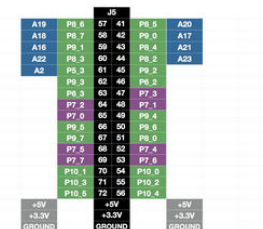
Revision 3.2



J5 41 57 66 72



GROUND  
GROUND  
+3.3V

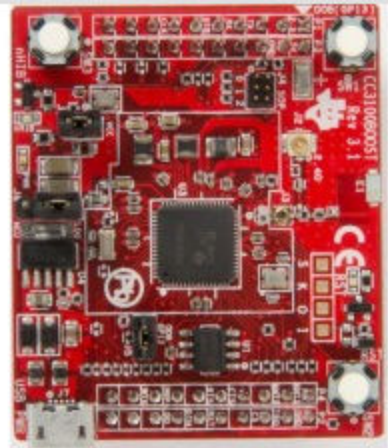


+5V  
+3.3V  
GROUND

© 2015 Energia  
Reel Vizio, 2012-2015  
energia.com.au

[http://energia.nu/pin-maps/guide\\_msp432p401r/](http://energia.nu/pin-maps/guide_msp432p401r/)

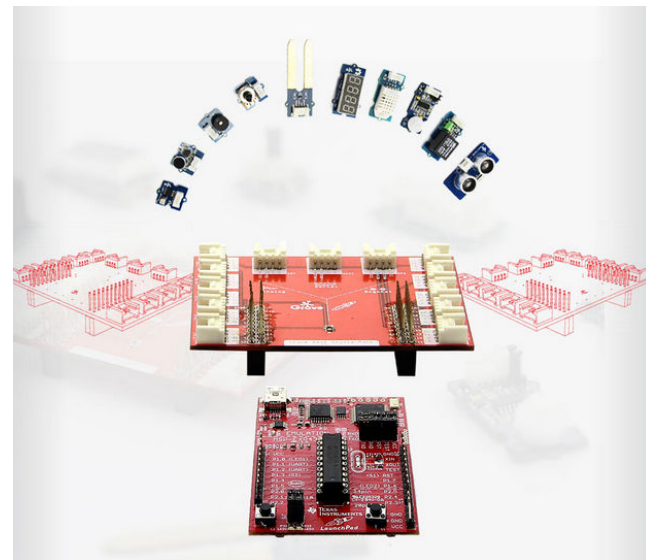
# What are BoosterPacks?



**SimpleLink Wi-Fi CC3100**

\$19.99

<http://www.ti.com/tool/cc3100boost>



**Grove Starter Kit for LaunchPad**

\$59

<http://www.seeedstudio.com/depot/Grove-Starter-Kit-for-LaunchPad-p-2178.html>

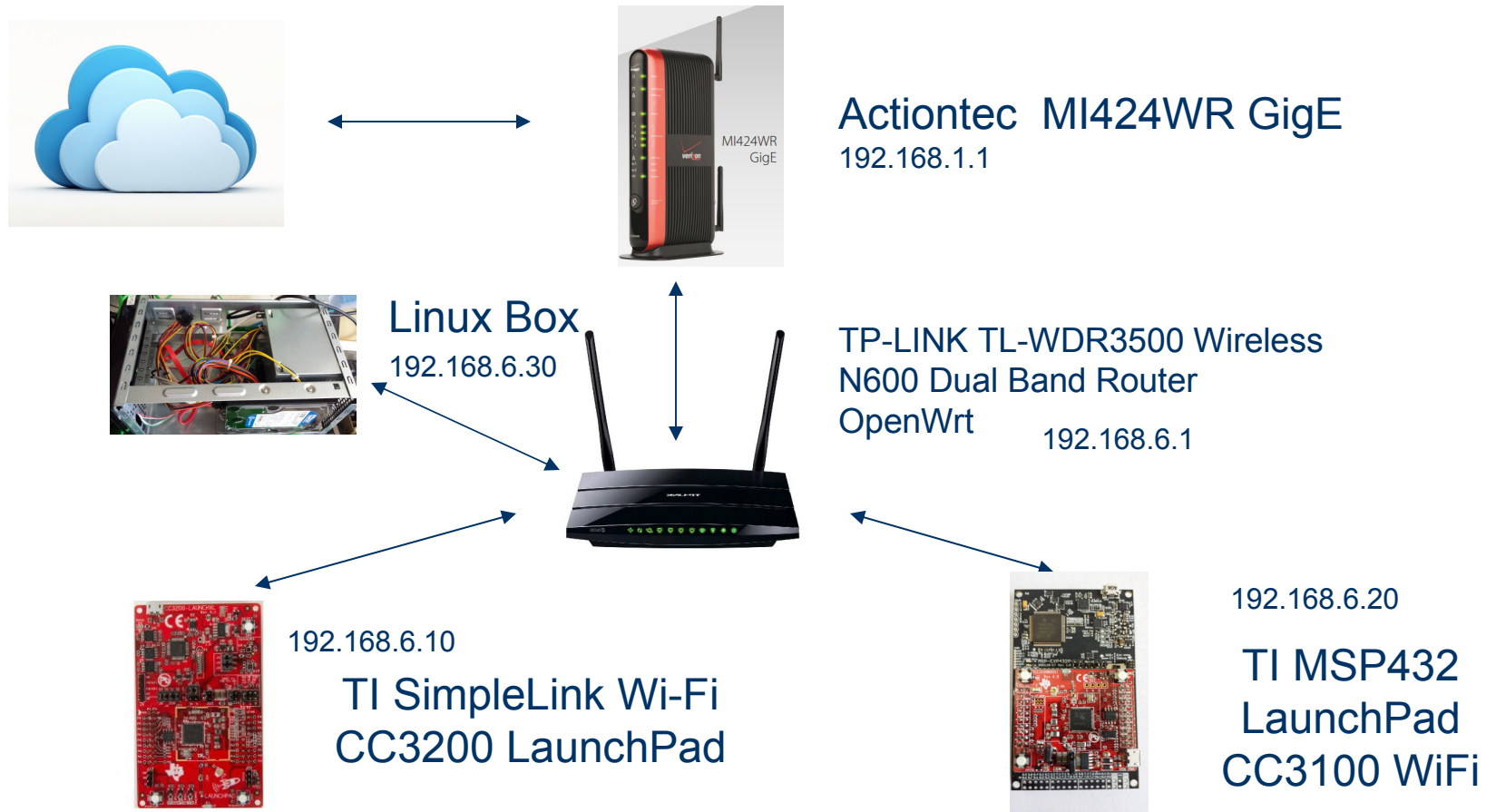
BP	Connected to CC3100, used by Energia
BP-NA	Connected to CC3100, but not used by Energia
SU	Serial UART
SPI	SPI
AR	Analog Read
DR-DW	digitalRead and digitalWrite
DR-DW-AW	digitalRead and digitalWrite and analogWrite

# Example App Pin Mappings

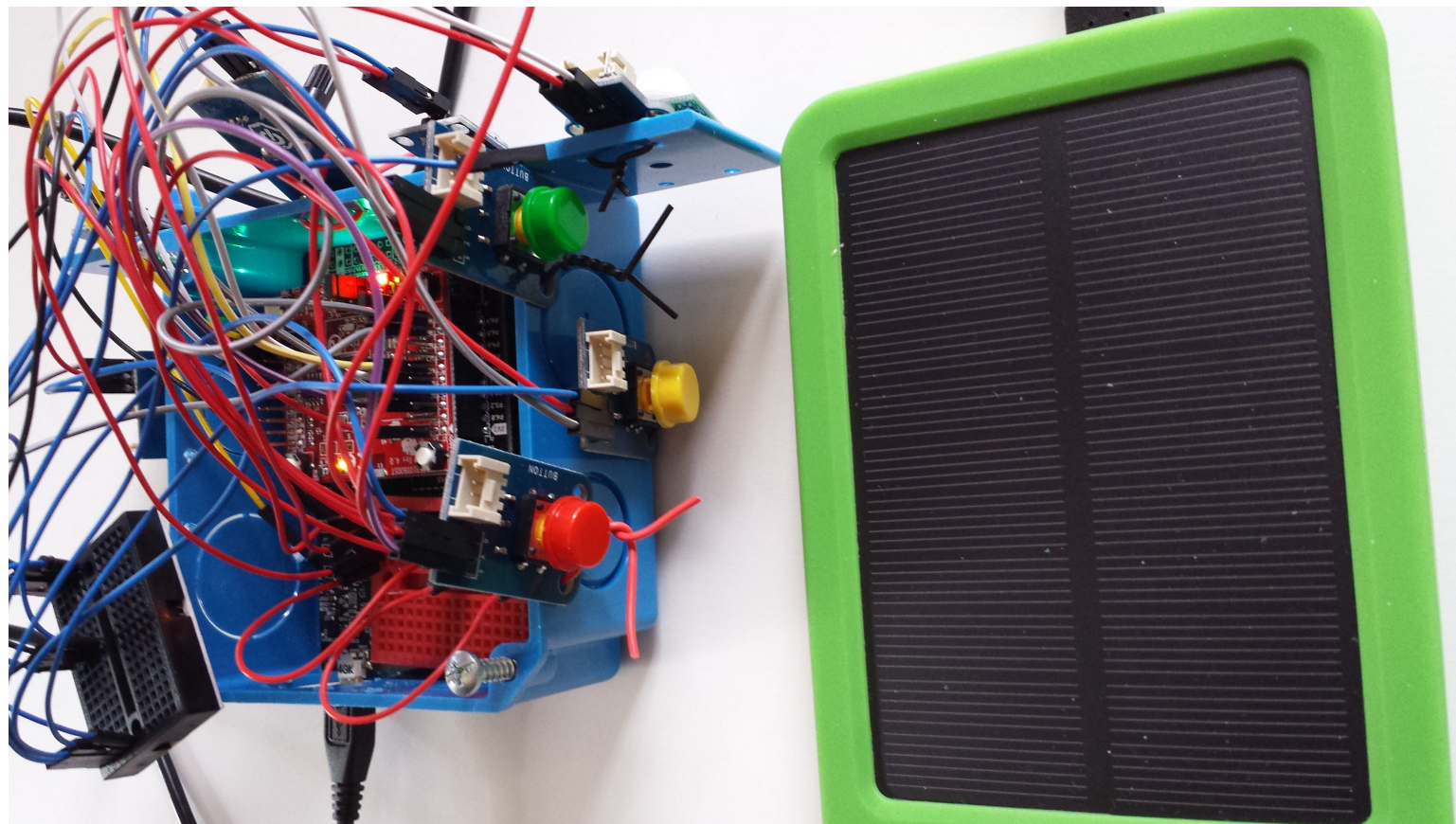
MSP432											
#	System	My App	#	System	My App	#	System	My App	#	System	My App
1	BP		21	5V		40	DR-DW-AW		20	BP	
2	DR-DW		22	GROUND		39	DR-DW-AW		19	BP	
3	BP-NA		23	DR-DW or AR	RED_BUTTON	38	DR-DW-AW		18	BP	
4	BP-NA		24	DR-DW or AR	YELLOW_BUTTON	37	BP-NA		17	DR-DW	
5	BP-NA		25	DR-DW or AR	GREEN_BUTTON	36	DR-DW		16	RESET	
6	DR-DW		26	DR-DW or AR	BLUE_BUTTON	35	BP-NA		15	BP	
7	BP		27	DR-DW or AR		34	BP-NA		14	BP	
8	DR-DW		28	DR-DW or AR		33	BP-NA		13	DR-DW	PIR
9	DR-DW		29	DR-DW or AR	POT_1	32	DR-DW-AW		12	DR-DW	YELLOW_LED
10	DR-DW		30	DR-DW or AR	POT_2	31	DR-DW-AW	BUZZER	11	DR-DW-AW	
CC3200											
#	System	App	#	System	My App	#	System	My App	#	System	My App
1	BP		21	5V		40	DR-DW-AW		20	BP	
2	DR-DW		22	GROUND		39	DR-DW-AW		19	BP	
3	BP-NA	RED_BUTTON	23	DR-DW or AR		38	DR-DW-AW		18	BP	
4	BP-NA	YELLOW_BUTTON	24	DR-DW or AR		37	BP-NA		17	DR-DW	
5	BP-NA	GREEN_BUTTON	25	DR-DW or AR		36	DR-DW		16	RESET	
6	DR-DW	BLUE_BUTTON	26	DR-DW or AR		35	BP-NA		15	BP	
7	BP		27	DR-DW or AR		34	BP-NA		14	BP	
8	DR-DW	PIR	28	DR-DW or AR		33	BP-NA		13	DR-DW	
9	DR-DW		29	DR-DW or AR	POT_1	32	DR-DW-AW		12	DR-DW	YELLOW_LED
10	DR-DW		30	DR-DW or AR	POT_2	31	DR-DW-AW	BUZZER	11	DR-DW-AW	

*Manage Data Locally While Sharing Globally  
With User-Controlled Programs and Preferences*

## Weave it into IoT Network Topology



# Energy Efficient - Try Solar!



“OpenWrt is described as a Linux distribution for embedded devices.”

# OpenWrt

Wireless Freedom

[Development](#) [Documentation](#) [Downloads](#) [Wiki](#) [Forum](#)

## What is OpenWrt?

OpenWrt is described as a Linux distribution for embedded devices.

Instead of trying to create a single, static firmware, OpenWrt provides a fully writable filesystem with package management. This frees you from the application selection and configuration provided by the vendor and allows you to customize the device through the use of packages to suit any application. For developer, OpenWrt is the framework to build an application without having to build a complete firmware around it; for users this means the ability for full customization, to use the device in ways never envisioned.

[> Supported Devices](#)

[Comments](#)

## Chaos Calmer 15.05-rc1

The OpenWrt developers are proud to announce the first release candidate of OpenWrt Chaos Calmer.



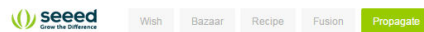
### CHAOS CALMER (15.05 RC1)

```
* 1 1/2 oz Gin           Shake with a glassful
* 1/4 oz Triple Sec     of broken ice and pour
* 3/4 oz Lime Juice     unstrained into a goblet.
* 1 1/2 oz Orange Juice
* 1 tsp. Grenadine Syrup
```

# Energia Futures

- Addition of Libraries
  - Tone()
- Support for additional LaunchPads
  - CC3200
  - SensorTag
- Future is Multi-Tasking
  - No new “native” ports, but some single-task optimizations when running TI-RTOS
- And more goodness ...

# Where to find parts? Sensors?



Link Start Your Project | [Sensors](#) | [Our Services](#) | [Manufacturing Capabilities](#) | [Part To Order](#)

## MANUFACTURING CAPABILITY

Seed has two agile manufacturing center located in Shenzhen and San Francisco now. Shenzhen manufacturing center provide one-stop service from co-design to tooling, from prototyping to mass production, abundant industrial resource supported us for maximum to meet customer demand. The small manufacturing center in San Francisco, we provide more convenient and fast prototyping service from 1~100pcs for makers near to Bay Area. Seed has passed the ISO 9001:2008 quality system certification, that is available for delivering high quality products to customers.



## WHAT MACHINES DO WE HAVE?



Colored buttons from <http://www.adafruit.com>

*jumper cables and accessories from Amazon.com*

Sensors and Electronic Bricks from <http://www.seeedstudio.com> and <http://imall.iteadstudio.com/prototyping/electronic-brick.html>



# Think Modules too ...

Red Bear Labs



Introducing our new WiFi boards



RedBearLab CC3200



WiFi Mini

Available Now US\$39.9



<http://redbearlab.com/>

# Lessons Learned

- Familiar and Fun
- Relatively Low Cost
- Vast Introduction to Landscape of
  - Computers / Hardware
  - Electronics
  - Programming / Software
  - Communications / Radios / Wireless
- Some tricks you'll learn on the fly
  - Flaky cables, shared power rails, beware the motors

## Q&A - Panel

- "What is the operating system of the sensor world?"
- Panel Discussion
  - Zigurd Mednieks
  - Arun Thomas
  - Brian DeLacey

# Next Month, Next Meeting



Kurt and team were away for this meeting competing in Taiyuan City, China with the Asia SuperComputer Community.

Kurt returns for the 6/17/15 Meeting to talk about

*Linux in Supercomputing: Trends in High Performance Computing*